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(54) APPARATUS FOR PRODUCING TRANSVERSE WELD SEAMS IN A TWO-PLY WEB OF PLASTICS FILM

(71) We, WINDMOLLER & HOLSCHER, a German Kommanditgesellschaft, of 48–52 Münster strasse, 454 Lengerich, Westphalia, Federal Republic of Germany, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an apparatus for producing transverse weld seams in a continuously fed two-ply web of plastics film, comprising a rotary welding cylinder about which the web is partially slung and which is provided with a plurality of welding bars at its periphery.

Prior U.S. Patent Specification No. 2,815,063 discloses such a welding cylinder in which six welding bars are provided at the periphery. The web to be welded is guided around the welding cylinder by three feed belts which are also slung about the cylinder and serve to drive the cylinder. The spacing between adjacent transverse seams in the web corresponds to the spacing between two adjacent welding bars at the cylinder periphery. An extremely large cylinder is required having a periphery measuring six times the smallest spacing between adjacent weld seams. Adjustment to larger seam spacings is effected by increasing the spacing between adjacent welding bars. For this purpose the distance between all the welding bars from the rotary axis of the cylinder is increased simultaneously by comparatively complex adjusting means consisting of a rigid frame in which the welding bars are mounted for radially outward movement together with screw spindles and bevel gears.

In this construction of welding cylinder, its diameter is considerably increased when the welding bars are set to a wide spacing. With correspondingly long screw spindles and their mountings, the cylinder is quite heavy and bulky and therefore has a comparatively high moment of inertia.

Further, as the cylinder diameter is increased, the feed belts that are passed about the cylinder and the web of plastics film extend along straight chords of the imaginary cylinder and consequently the periphery of the cylinder is in reality a regular hexagon instead of circular. The uniformly moving feed belts and the plastics web therefore tend to drive the welding cylinder irregularly. The resultant accelerating forces are likely to upset the positive engagement between the welding cylinder and the feed belts which also serve as drive belts for the cylinder and thus there is a danger of displacements taking place between the web and the welding bars. In most cases, however, the cylinder is unsuitable because of its large size because the cylinder diameter is always twice the largest spacing to be produced between adjacent weld seams.

German Patent Specification No. 2,004,944 discloses a welding cylinder having three transverse welding bars, in which a rectilinear path for the web between the welding bars is avoided by means of radially adjustable cylinder wall segments. The welding bars have a fixed radius but can be moved to and from an operative position. As a result, and because of the shape of the wall segments, adjustment of the cylinder diameter is possible only within comparatively narrow limits. The smallest spacing between transverse weld seams is again equal to the spacing between two welding bars. If this apparatus were to be constructed so that any desired spacing between consecutive weld seams may be selected, the equipment would again bcome bulky and in any case for larger radial adjustments of the wall segments there would again be a rectilinear course for the web between the peaks of each wall segment and the adjacent welding bars.

French Patent Specification 1,551,880 discloses a welding cylinder similar to that of the aforementioned U.S. patent specification, in which an increase in the cylinder

diameter is again possible by means of screw-threaded spindles for the purpose of setting any selectable weld seam spacing, the two-ply web being passed along a straight line between the individual welding bars. To increase the spacing between the weld seams, individual welding bars may be de-energised. The weld seam spacing can be automatically adjusted during operation of the apparatus. The basic disadvantages of the apparatus that have already been discussed in connection with the other prior specifications are also to be found in the apparatus of the French specification.

The present invention aims to provide a transverse welding cylinder which is of minimum bulkiness, is adapted to produce weld seams at any desired spacing in a simple and reliable manner, and minimises slip between the web to be welded and the means for effecting the welding.

According to the invention, an apparatus for producing transverse weld seams in a continuously fed two-ply web of plastics film comprises a rotary welding cylinder about which the web is partially slung and which is provided with a plurality of welding bars at its periphery, wherein

a) the welding bars are steplessly adjustable radically of the cylinder

b) the spacing between adjacent welding bars when the latter are in their fully radially retracted position is equal to half the smallest desired spacing between adjacent said transverse weld seams

c) steplessly radially adjustable supporting members for the web are provided between the welding bars, and

d) the welding bars are operable by a sequence control in a sequence which is independent of the number of said welding bars.

By selecting a number of welding bars so that the spacing between adjacent welding bars is equal to half the smallest desired spacing between adjacent weld seams and by means of a sequence control that makes the welding bars operative in accordance with the desired seam spacing but independently of the sequence of the welding bars around the cylinder, an increase in the diameter of the cylinder of 1:2 can be dispensed with; instead, the maximum increase in diameter can be kept less than 1:1.5. This makes it possible to construct a stable and compact welding cylinder without sacrificing the possibility of obtaining large spacings between the weld seams because the maximum seam spacing can be even larger than the cylinder periphery. Further, since even with the smallest seam spacing there are disposed between the operative welding bars two correspondingly radially adjusted supporting members and one welding bar which is inoperative, the web will always be led about the cylinder in a path which very closely approximates a cylinder.

For sequence controlling the welding bars, a cam may be provided which rotates in sequence with the welding cylinder and which influences the sequence control through a number of micro-switches corresponding to the number of welding bars. This will ensure that the required welding bars are operated in the correct sequence independently of the cylinder speed.

The welding bars are preferably movable from an operative position, at which they make contact with the web, to an inoperative position, at which they are disengaged from the web. Those welding bars that are not required can therefore simply be moved to the inoperative position, this being desirable because the inoperative welding bars may still be hot. This would also make it possible to use permanently heated welding bars. For the purpose of moving the welding bars to and from their operative positions and also for pressing them onto the web, each welding bar may be provided with a co-rotating compressed air cylinder which is preferably equipped with a co-rotating control valve. Such compressed air cylinders with control valves facilitate rapid application of the welding bars to the web.

In a preferred embodiment of the invention, means for effecting radial adjustment of the welding bars and of the supporting members comprise two helical screws which are interconnected by a tube disposed centrally of the welding cylinder and which are engaged with holding means for the welding bars and supporting members. Such a construction is stable and involves few moving parts, in contrast with known apparatus where separate adjusting screws or other adjusting means are provided for each welding bar and for each supporting member. In the preferred construction according to the invention, adjustment of all the components at the periphery of the cylinder is very simply effected by turning the two interconnected helical screws relatively to the cylinder.

An example of the invention will now be described with reference to the accompanying drawings, wherein:—

Fig. 1 is a side elevation of the welding apparatus;

Fig. 2 is a section through one of the welding bars taken on the line II–II in Fig. 1 when the welding bar is in an inoperative position, and

Fig. 3 is a section on the line III–III in Fig. 2, again with the welding bar in the inoperative position.

The welding apparatus comprises a welding cylinder 1 about which a two-ply web 2 is partially slung to an extent determined by the position of two guide rollers 3 about

which the web is passed. In its travel about the cylinder 1, the web 2 is pressed onto the cylinder by an endless belt 4. The inoperative or return run of the belt 4 passes about direction-changing rolls 3, 5 and 6. The The roll 6 can be moved into the chain-dotted position 6′ of Fig. 1 and serves as a tensioning roll so as to compensate for adjustments that are made to the cylinder diameter. The cylinder 1, guide rollers 3 and direction-changing rolls 5, 6 are mounted on a frame (not shown) which also supports drive means for the cylinder.

The welding cylinder 1 comprises two brackets 7, 7′ (Fig. 2) which are interconnected for rotation in unison by means of a shaft 8 to which they are secured by keys 9. Between the brackets 7, 7′ there are five welding bars 10 which are uniformly distributed about the cylinder periphery and which can be simultaneously radially adjusted by displacing means 11, 11′. Each displacing means comprise holding means 12, 12′ to which the welding bar 10 is screw-connected. The holding means 12, 12′ are each guided in a radial direction on a bevel gear 14, 14′ by means of an associated helical screw 13, 13′. For lateral support of the holding means, the brackets 7, 7′ are secured to guide bars 15. Supporting members 16 (Fig. 1) for reducing the gap between adjacent welding bars are connected to the bevel gears 14, 14′ in a manner similar to that of the welding bars 10 so that, if the bevel gears 14, 14′ are turned relatively to the brackets 7, 7′, all the welding bars 10 and supporting members 16 will be simultaneously and uniformly adjusted along the helical screw 13, 13′. For this purpose the bevel gears 14, 14′ are interconnected by a sleeve 17 on which they are mounted by keys 18 and they are mounted for rotation on the shaft 8 by means of roller bearings 19. The brackets 7, 7′ carry pinions 20 which engage with the bevel gears 14, 14′ and which are provided with a socket 21 for an adjusting tool such as a key. By turning one of the pinions 20, relative rotation will take place between the bevel gears 14, 14′ and the brackets 7, 7′, whereby the welding bars 10 and supporting members 16 will all be simultaneously radially adjusted. If radial adjustment is desired to be effecteed during operation of the apparatus with a view to altering the spacing between adjacent weld seams produced in the web, the helical screws could be adjusted by means of a servo motor which is electrically energised through slip rings. For this purpose the hub of one of the gears 14, 14′ may be provided with spur gear teeth, in which case the bevel gearing and the pinions 20 can be dispensed with.

Each welding bar 10 consists of a frame member 22 (Figs. 2 and 3) in which a movable pressure member 23 is mounted by means of pins 24. Crank arms 25 and 26 are pivoted to the pins 24 and these crank arms are hinged to a welding beam 27 by pins 28. A connecting rod 29 between the two crank arms completes a parallelogram linkage so that, when the crank arms 25, 26 are rotated by means of a compressed air cylinder 30, uniform radial movement of the welding beam 27 takes place relatively to the frame member 22. The compressed air cylinder 30 is connected by conduits 31 to a control valve 32 on the outside of the bracket 7. Each of the five welding bars 10 is associated with a separate control valve 32. The supply of compressed air from the outside is effected through a common air conduit 33 for all the control valves. The supply of electrical energy takes place through leads 34 and slip rings (not shown). The supply of electrical energy to the welding beams 27 is analogously effected through slip rings and through leads 35. Heating elements 36 at the top of the welding beams 27 permit selective operation to provide a single weld seam or two juxtaposed weld seams. The surfaces of the heating elements 36, which are in strip form, are covered with a polytetrafluoroethylene sheet 37 which prevent adhesion to the web 2 and which are passed about winding and tensioning rollers 38 provided on each welding beam 27.

Fig. 1 indicates the range of adjustment that is possible for the welding cylinder 1. The smallest cylinder diameter is indicated where the welding bars 10 and supporting members 16 are shown in chain-dotted lines and, together, they form an almost continuous cylindrical surface. When the welding bars 10 and supporting members 16 are moved radially outwardly to define the largest possible cylinder diameter, gaps are formed between adjacent such radially movable parts and here the web 2 will bridge the gaps along straight lines. This will not, however, detrimentally influence guiding of the web 2 because the belt 4 follows the same path as the web 2 and presses the web to the welding bars 10. In any case, the gaps between the welding bars 10 and supporting members 16 are such that the web will still be fed along a substantially cylindrical path.

The illustrated construction is based on the concept of increasing the spacing between adjacent weld seams to a multiple of the cylinder periphery by making the appropriate welding bars 10 inoperative through electrical switching operations. The distance between adjacent weld seams will always be a whole number multiple of the set spacing between adjacent welding bars, the smallest seam spacing corresponding to twice the spacing between adjacent welding bars. To adjust the seam spacing, a different control programme can be selected

for the welding bars that are to be energised or de-energised; however, this would result in progressive adjustment of the seam spacing. To permit stepless adjustment, the welding bar spacing must be adjusted instead of or in addition to choosing a different control programme, by radially adjusting the welding bars 10 and supporting members 16.

Depending on the seam spacings that are likely to be required in practice and the minimum welding cylinder diameter that is required to provide the longest possible welding time for each seam, it will generally be sufficient for only three control programmes to be provided for which either one, two or three welding bars are left inoperative.

The full-line positions of the radially adjustable parts in Fig. 1 will produce the largest possible spacing between adjacent weld seams. The two welding bars 10 nearest the guide rollers 3 are energised and their welding beams (27 in Fig. 3) are passed onto the web 2. The other three welding bars 10 in Fig. 1 are de-energised and therefore inoprative, their welding beams being retracted. Before a previously energised welding bar 10 again reaches a welding position in relation to the web that is being fed onto the cylinder, this welding bar, as well as the two welding bars following immediately behind it, are switched off. After the web has made contact with three inoperative welding bars, a previously inoperative welding bar 10′ is energised, reaches the welding position and produces a weld seam.

In the illustrated construction with five welding bars, the cylinder will have returned to a starting position after five weld seams have been formed. With the illustrated largest size of four-fifths of the cylinder periphery, this corresponds to four complete cylinder revolutions. All the welding bars are re-energised at regular time intervals. The smallest size can be carried out with two-fifths of the cylinder periphery, all the bars 10 and members 16 of the cylinder then being in the chain-dotted line position of Fig. 1 for the smallest cylinder diameter. In this case, the operating cycle will then be repeated after every two complete cylinder revolutions, two welds being effected simultaneously in the operative region. The useful welding path is the same for all programmes, namely almost four-fifths of the cylinder periphery, whereby good heat transmission is ensured between the heated welding bar and the web to be welded.

A cam disc 39 rotating together with the cylinder shaft 8 consecutively operates five micro-switches 40 during a complete cylinder revolution, the micro-switches being uniformly distributed in the peripheral direction of the cylinder and mounted at a fixed position on the machine frame. A sequence control device (not shown) is thereby notified of the cylinder position at any one time, the sequence control thereby being dependent on the cylinder position but independent of the cylinder speed. Adjustment to a new control programme in which the weld seam spacing is only three-fifths or two-fifths instead of four-fifths of the cylinder periphery can very simply take place by actuating a manual switch on the sequence control device. This completely avoids operating mistakes such as those that could occur when replacing welding bars and all their electrical connections. Adjustment of the cylinder diameter can likewise be effected very simply by turning one of the pinions 21 with a key. This is carried out whilst the cylinder remains mounted in the machine frame, it only being necessary to adjust the tension of the belt 4 by means of the roller 6. As already mentioned, fully-automatic adjustment would be possible by means of a servo motor and provision may be made to ensure that the desired weld seam spacing is adjusted steplessly.

WHAT WE CLAIM IS:—

1. Apparatus for producing transverse weld seams in a continuously fed two-ply web of plastics film, comprising a rotary welding cylinder about which the web is partially slung and which is provided with a plurality of welding bars at its periphery, wherein:

a) the welding bars are steplessly adjustable radially of the cylinder

b) the spacing between adjacent welding bars when the latter are in their fully radially retracted position is equal to half the smallest desired spacing between adjacent said transverse weld seams

c) steplessly radially adjustable supporting members for the web are provided between the welding bars, and

d) the welding bars are operable by a sequence control in a sequence which is independent of the number of said welding bars.

2. Apparatus according to claim 1, wherein the welding bars are movable from an operative to an inoperative position.

3. Apparatus according to claim 2, wherein each welding bar is provided with a co-rotating compressed air cylinder for moving it to and from the operative position and for pressing it to the web.

4. Apparatus according to claim 3, wherein each compressed air cylinder is equipped with a co-rotating control valve.

5. Apparatus according to any preceding claim, wherein means for effecting radial adjustment of the welding bars and of the supporting members comprise two helical screws which are interconnected by a tube disposed centrally of the welding cylinder

and which are engaged with holding means for the welding bars and supporting members.

6. Welding apparatus substantially as hereinbefore described with reference to the accompanying drawings.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

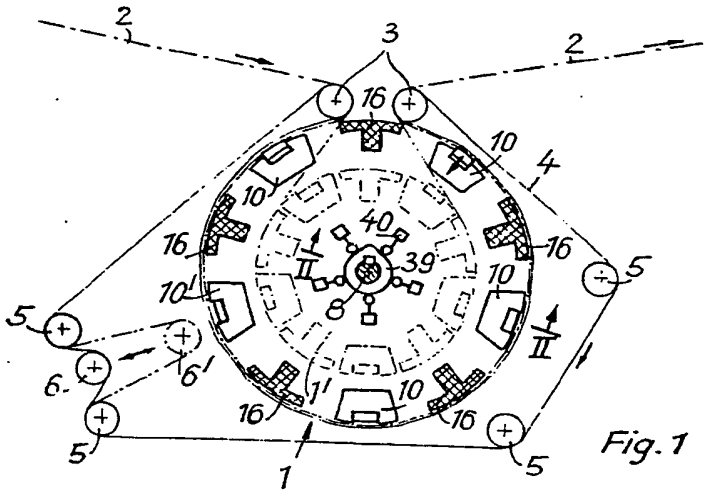

Fig. 1

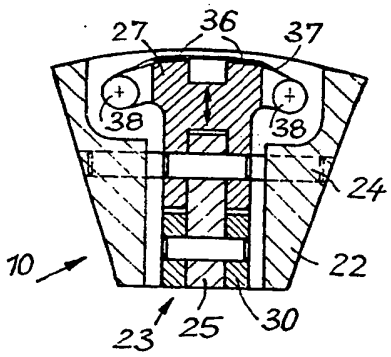

Fig. 3

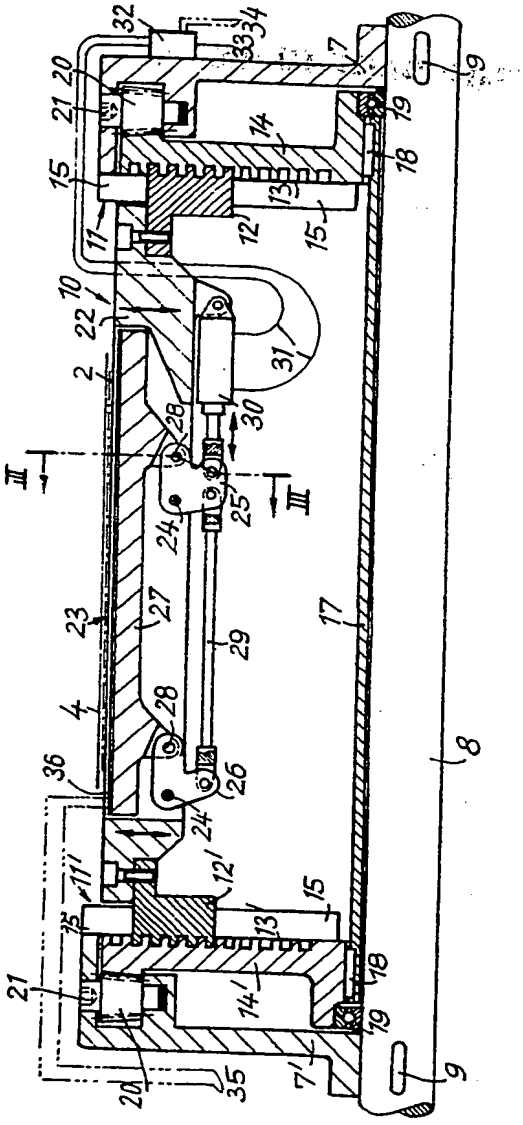

Fig. 2